FINAL REPORT

19970405

IMPACT OF PRECISION FARMING ON ECONOMIC RETURN FROM CROP INPUTS

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FINAL

Final Report
The Impact of Precision Farming Technology on Economic Returns from Crop Inputs

April 1998 – March 2002
Project # 97000405

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Executive Summary

This project is a compilation of several large scale and on-farm research trials, all of which have the common objective: to increase net economic return per acre to northeast Saskatchewan producers. Additional benefits that were considered were environmental issues, particularly with the variable rate technology, by targeting the soils that requests additional fertility, while not overfertilizing soils that have adequate levels.

All projects have a precision farming focus in either their anticipated outcome or their methods of testing, and have primarily been focused on the crop input sector. Producers who wished to evaluate some kind of technology generated on-farm yield maps, to aid in their decision making process for subsequent years. This is particularly relevant in the crop input sector, due to rapid development of new crop varieties, crop pesticides, and crop rotation issues.

Technical Report

The technical report will include a brief summary of each of the trials and achievements completed on a yearly basis, and some conclusions based on the results obtained. Also to be discussed will be recommendations for further study, as well as a comment on the output and measures of the project, and how the average northeast Saskatchewan producer has accepted precision farming. Additional projects developed after this agreement was initiated are reported in the appendices.

a. Background and Objectives

This project is a compilation of several large scale and on-farm research trials, all of which have the common objective: to increase net economic return per acre to northeast Saskatchewan producers. All projects have a precision farming focus in either their anticipated outcome or their methods of testing, and have primarily been focused on the crop input sector.

In 1998, NARF gained access to the most comprehensive software program available for field mapping. SSToolbox enables producers and researchers to import producers' raw data taken from their yield monitors or field scouting equipment, and compile that information into layers that will serve as a benchmark for variable rate technology. The actual operation of the program remains a mystery to all but a few people, as the program is not as "user friendly" as other equipment available. This technology has initiated other projects, which will be reported in the future from other AFIF projects.

b. Activities and Achievements

1998

i. Herbicide tolerant canola variety trial Vince

This was one of the first trials harvested using field mapping technology, and therefore yields were taken with the equipment, as well as with a weigh wagon. There were virtually no differences between the two methods of measuring yield, so therefore the producers were able to use their equipment with confidence, provided it was calibrated appropriately. The intent of the project was to determine yield of the different varieties and herbicide tolerance systems. All herbicide treatments were applied as recommended by label, with the only difference in seeding between the varieties is that the Liberty Link hybrids were sown at 5 lbs/ac rather than 6 lbs/ac, which is the general industry recommendation. An economic analysis was included as well, to determine the entire cost of the different herbicide tolerance systems, for a net return per acre. Results are summarized in the following table, with the entire project available on the Walker Seeds website (www.walkerseeds.ca).

Variety By Technology	Net Bu / Ac	$ Gross / Ac @ $8 / Bu	Less $ / Ac for Seed, Chem, Tech	$ Net Gross Return / Ac
Pursuit Smart				
45A71	24.9	199.12	45.84	153.28
46A72	22.7	181.44	45.84	135.60
Roundup Ready				
LG3295	23.2	185.86	39.40	146.46
45A51	22.8	182.17	40.30	141.87
Liberty Link				
2163	27.3	218.73	45.25	173.48
Independence	24.5	195.72	34.21	161.51
2153	27.2	217.40	47.50	169.90
Conventional				
Hyper-Star	24.8	198.43	45.11	153.32
Ebony	30.7	245.50	31.91	213.59
AC Excel	26.0	207.81	24.95	182.86
44A89	20.8	166.38	33.65	132.73

ii. Effect of fungicide on yield

a. *Barley* - Portions of five different fields of barley were applied with Tilt, a foliar fungicide that controls several leaf diseases that can reduce grain yield and quality. Conditions for the development of these leaf diseases were ideal in 1998, and the application of the fungicide increased grain yield by an average of 15.9 bushels / acre. In two of the fields, the grain plumpness percentage increased 20 to 25 %.

b. Wheat – Tilt was also applied to two wheat fields. However, results in 1998 were inconclusive, and demanded further study.

c. Canola – Benlate was applied by plane in a multi-strip trial in a field of 45A71 canola. Benlate inhibits the development of sclerotinia in canola, and in this trial, the average of the treated plots was 32.0 bushels/ac, while untreated was 30.3 bu/ac. Considering the cost of Benlate and application at $21/ac, this was uneconomical in 1998, but certainly warrants further study in predicting the development of sclerotinia in canola, as control may not have been effective, or applied too late.

d. Peas – Pea yields can be greatly affected by foliar diseases. Kumulus, for the control of powdery mildew, and Bravo, for the control of ascochyta blight, were applied together on two fields. These trials were strip trials and non-replicated, but there was some yield differences, summarized below.

Variety	Treatment	Yield (bu/ac)
U/C Princess	Kumulus & Bravo	33.2
	Kumulus	27.6
U/C Gitano	Kumulus & Bravo	51.7
	No fungicide	44.4

iii. Effect of seed treatment on pea yield
Four fields of peas had a portion of the seed treated with the commercially available seed treatments of Apron and Thiram, which are used to control seedling blights caused from *Pythium spp*, and also damping off, another seedling development disease. In all four fields, there were no significant differences in grain yield.

iv. Effect of seeding rate of field pea on yield
CROMA yellow peas were seeded at two and three bushels per acre, and yields were mapped. CROMA has a relatively large seed size (300 gram TKW), so the recommended seeding rate, according to the Saskatchewan Pulse Growers Association, should be closer to three bushels per acre. Actual yields were 48.0 bushels per acre at the three bushel seeding rate, and 47.5 bu/ac at the two bushel seeding rate. There was some field variability noted outside of the seeding rate project, and the trial was not replicated, but the grower also had noted that if the seed is of good quality, and weed pressure is limited, yields could be maintained with lower than recommended seeding rates.

v. Other
Additional trials were conducted in association with the Melfort Research Station on the NARF farm site. This was done partially to gain more exposure for NARF by being able to participate in the Melfort Research Farm Annual Field Day. The MRS conducted all work associated with these trials, and results may be obtained through them. The research and demonstration trials included the following:

a. Saskatchewan Soil Conservation Association – Do's and Don'ts of Direct Seeding
b. Agrevo Canola Variety Trial
c. Oat Variety Trial
d. Fall Seeded Canola

1999
i. Soil sampling methods "Precision Farming – Northeast Agriculture Research Foundation" (AFIF #19980166) This is a separate project that is also funded by AFIF, but which falls under the main funding protocol. This trial relates specifically to field scouting and soil sampling procedures that will lead to predicting appropriate nitrogen rate application on a site-by-site basis using variable rate nitrogen (VRN) technologies. The last progress report was delivered in January 2002 by Cory Willness and is attached in Appendix A.

ii. Micronutrient Fertility

a. Copper on wheat
A quarter of land in the Weldon area was sampled for fertility levels, including micronutrients. Results showed that copper was of limiting and marginal availability in 13 of the 18 samples. Copper was foliar applied in two passes down the field. Plant tissue analysis was done the same day, but this analysis did not show potentially limiting levels of copper. Yield analysis showed that there was no responses to copper application, indicating inconclusive or inadequate soil testing results. It should be noted

that a positive yield increase was noted in a trial at another location, which also showed potential limiting levels by soil test.

b. Boron on canola

The boron application trial also provided inconclusive results, but did indicate the need to replicate the applications many times over the field, as there was much more spatial variability within treatments than between treatments.

iii. Variable rate system (Cargill)

This project was a prelude to AFIF Project #19980166 (see Appendix A). The intent of the project was to develop a comprehensive database of a parcel of land using all available mapping and soil analysis available, such as grid sampling and grain yield analysis. From the different layers of information, the producer will be able to develop a map for variable rate nitrogen application. This was initiated with three producers, however only one maintained the mapping system.

iv. Effect of fungicide on yield

There was just one trial of Tilt application on CPS wheat (cv AC Crystal). There was a 26 % yield response to Tilt application versus untreated, which should make any producer look at this option.

v. Effect of seed treatment on yield

The brand name seed treatments of Vitaflo Dual, Dividend XL, and Raxil FL were compared against no seed treatment on AC Crystal CPS wheat. The same treatments were also sprayed with Tilt, a foliar real fungicide, for a total of eight different treatments. There were no significant results between the three seed treatments versus the check, nor between the Vitaflo/Tilt, Dividend/Tilt, Raxil/Tilt and untreated/Tilt. However, there was a significant yield increase between the four plots sprayed with Tilt versus the four plots unsprayed. This trial was not replicated, but the average yield increase due to Tilt was more than 30 %. Results are summarized in the following table.

Treatment	Yield (bu/ac)	% of no Treatment
None	69.3	100
Vitaflo Dual	67.1	97
Dividend	65.3	94
Raxil FL	72.2	104
None/Tilt	94.1	136
Vitaflo Dual/Tilt	96.2	139
Dividend/Tilt	88.4	128
Raxil FL/Tilt	95.0	137

vi. Dry bean production in NE Saskatchewan (Saskatchewan Pulse Growers Association Project = AGR9905)

The Saskatchewan Pulse Growers Association funded a project to evaluate the potential for dry bean production in northeast Saskatchewan. With price and yield potential of dry beans in Saskatchewan, dry bean production has been viewed as the next area of growth in pulse crop production. On-farm trials have shown that it is not an easy crop to grow, and that there are some significant climatic and varietal challenges that need to be addressed before dry beans will be grown on a significant level in northeast Saskatchewan. Plots were seeded in *1999* and *2000*, and the final report was submitted to the Saskatchewan Pulse Growers Association in 2001. (See Appendix B)

vii. Effect of fertility and variety on yield

A canola variety trial was seeded in the Brooksby area, to analyze potential yields of fifteen canola varieties, the effect of different fertility management schemes, the effect of Boron on yield, and if there were any significant varietal interaction with the fertilizer management. It was difficult to determine if there was any specific variety interaction with the differences in the two fertility management variables, but there were significant differences in the yields of the varieties. The results are summarized in the following tables.

Variety Summary

Variety	Herbicide System	Yield bu/ac	% of Q2
2273	Liberty Link	50.2	108
Canterra 1492	Conventional	49.2	106
Ebony	Conventional	48.7	105
2473	Liberty Link	48.4	104
2463	Liberty Link	47.8	103
46A73	Clearfield	47.3	102
LG 3295	Roundup Ready	47.1	102
Q 2	Conventional	46.5	100
LG 3235	Roundup Ready	45.5	98
45A51	Roundup Ready	45.4	98
Option 501	Conventional	45.1	97
SW Arrow	Roundup Ready	43.2	93
LG 3366	Conventional	43.2	93
Adv 700-567	Conventional	38.7	83
Hylite 201	Conventional	36.7	79

Fertilizer Summary

Fertilizer Treatment	Yield bu/ac	% of Standard
90N-30P-20S-10TS at seeding	45.7	100.6
Standard & 40N-20S Topdress	45.4	100

Boron Treatment	Yield bu/ac	% of Standard
No Boron applied	46.0	100
Boron applied	45.1	98.2

Notes on trial:
Standard fertilizer rate is 90N-30P-20S-10TS, fall banded
The Boron was applied with the Ronilan at the first stages of flowering
TS – Tiger Sulfate – CR

viii. Other

The Melfort Research Station continued to conduct trials on the NARF farm site, for mutual benefit. Trials included the following:

a. Saskatchewan Soil Conservation Association – Do's and Don'ts of Direct Seeding
b. Agrevo Canola Variety Trial
c. Oat Variety Trial
d. Fall Seeding and Fertility

2000

i. Effect of fungicide, timing of application and variety on yield

There were several locations for Tilt evaluation on wheat in 2000. Yield response by variety and field is summarized in the following table. Results were unexpected and dramatic, as average yield increase in the Brooksby area was 24 % for CPSR wheat, and 33 % for HRS wheat.

		Bu/ac	
Field	**Variety**	**Untreated**	**Tilt Applied**
1A	AC Crystal (CPSR)	57.5	73.3
1B	AC Crystal	66.6	69.4
2	AC Crystal	54.2	77.7
Average CPSR		59.4	73.5
3	AC Intrepid (HRSW)	50.0	63.0
	AC Intrepid	48.0	59.6
	AC Intrepid	45.6	57.2
4	AC Intrepid	39.6	55.2
5	AC Intrepid	38.1	49.8
	AC Intrepid	39.3	50.0
6	AC Barrie (HRSW)	34.1	55.6
	AC Barrie	38.5	48.3
	AC Barrie	44.8	52.4
7	5600 (HRSW)	34.0	55.5
	5600	41.1	55.9
Average HRSW		41.2	54.8

Included in field 1 data is the timing trial. Field 1A is an average yield for Tilt applied when the CPSR wheat was at full flag leaf, just prior to tillering. Field 1B was applied two weeks later, at full heading, with flowering 75 % complete, well after the recommended time of application. While the yield improvement due to Tilt application was not as dramatic as when it was applied at label recommendations, even late application resulted in economic yield improvements.

ii. Fungicide application by weather station disease modeling

This project was designed to test equipment that records climatic conditions that lead to the development of sclerotinia in canola. Once the climatic threshold is met, the station alerts the producer to spray within the next three days to alleviate the disease concern. At early flowering, the weather station informed the producer to spray, and Ronilan, a foliar fungicide, was applied at ½ rate. The weather station again alerted the producer to spray, but it was well past flowering and close to swathing, and Ronilan was not applied. The net yield increase by spraying Ronilan at ½ rate at the appropriate time was 3 bushels / acre, at a cost of $16/ac including application, which is close to the economic threshold.

iii. Satellite imagery

Satellite imagery, in a precision farming sense, is an infrared picture taken from a satellite of your field. Colour variations within the field depict differences in vegetative growth. In an agricultural sense, differences in plant stress can be visualized; the more stress a plant is subjected to, generally the poorer the yield potential. Grain producers would try to limit stress to maximize yields, so the satellite images were compared and correlated with the producers' yield maps and other maps generated by field scouting, such as topography, fertility, and soil pH. The more maps generated, including the satellite image, the more layers of information, and therefore this should lead to a more complete picture for variable rate technology. However, caution is advised with using satellite imagery as a primary field mapping tool. It is just a picture, taken from a great distance, and that picture may not necessarily be the most appropriate picture for agricultural purposes. It has since been suggested by others that producers not hold much hope for satellite imagery in aiding VRN recommendations.

iv. Forage breaking demonstration

It was decided to break an old forage demonstration on the research station, and it was a good opportunity to determine which method of stand termination was most effective and economical, without losing a year of production. Seven different forage species were used, and had one of the following treatments applied: burn / regrowth sprayed with Roundup @ 1 L/ac; shallow cultivation; Roundup @ 1 L/ac; and Roundup @ 2 L/ac. Each one of the treatments above had the following crops direct seeded into the stand: wheat (herbicide – Horizon); canola (Roundup Ready); and peas (Pursuit). Results were inconclusive as to which method was the most effective at killing the older forage stand, and also which method led to the highest yield of the following crop. It would have been best to replicate a trial such as this, since tremendous variability will occur on a trial like this. The positive note is that yields of the annual crops, over all four treatments were quite good, considering the difficult conditions that they may have had with available moisture, fertility, and competition.

			Yield
Crop			**(bu/ac)**
Wheat			26.5
Canola			25.7
Peas			39.9

2091

The worst drought in decades affected all but the northern fringe of the northeast, and limited the activity for NARF. In particular, there was a quarter section available that was originally intended for a satellite imagery project. There were germination problems in the field, which would have affected the results, and although it would be interesting to evaluate the picture generated, it would not have served any agronomic purpose.

i. Effect of seeding date on yield of canola (with funding from the Saskatchewan Canola Development Commission)
This project was initiated in 1999, for two consecutive harvests in 2000 and 2001. The different seeding dates were to include dormant seeding in the fall, early spring, and late spring. Three sites were seeded in 1999, of which only two were left for harvest and data analysis, due to very poor emergence. There was only one site seeded in 2000, for 2001 harvest. Results were inconclusive at best, although certainly some of the yield reduction for the fall seeded plots can be attributed to late spring frosts of May 2001, combined with dry soil conditions. Enclosed in Appendix C is the final report submitted to the SCDC, written by Nancy Evenson.

ii. Weather station disease modeling (with funding from the Saskatchewan Canola Development Commission)
This project was designed to test equipment available that records climatic conditions that lead to the development of sclerotinia in canola. This was previously described in 2000ii. The intent is to continue this project into the next year, as results were mixed, especially considering the hot and dry year of 2001, which were conditions not that conducive to sclerotinia development. A progress report, written by Dennis M^{c}Intosh, is attached in Appendix D, with the final progress report to be submitted in March 2003.

iii. EM 38 salinity mapping
In association with staff at PFRA in Melfort, a portion of the NARF land at the Melfort Research Station was mapped and sampled for salinity and conductivity levels. This was done in October. Unfortunately there are no results to discuss at this date.

iv. Effect of fungicide on wheat yield
In the Nipawin region, where there was adequate moisture in 2001, there was a HRS wheat (cv AC Elsa) field applied with Tilt, in the same manner as in previous years. A positive result was obtained, increasing the grain yield from 52.5 bushels/acre, to 64.9 bushels/acre. This is a 23 % yield increase.

v. Effect of Jumpstart on pea yield
In the Nipawin region, a pea field (cv Carneval) was seeded, with Soil Implant, a granular soil inoculant. Jumpstart is a phosphorous inoculant applied as a seed coat that aids in mineralizing soil phosphate, an important nutrient for seedling vigour and maturity. The seed was coated with Jumpstart on a portion of the field, and helped to improved yields from 40.2 bushels/acre to 44.8 bushels/acre, for a 12 % increase.

c. Results and Conclusions

Replication and randomization

On-farm research has a very important in the research community. On-farm research has shown producers that in some cases, management options made by several crop input companies may not perform on a field scale like they do in small research plots. There is nothing like proof on your own land, with your own equipment, under your growing conditions and management, to help you make decisions for next year. However, one of the problems with acceptance in the research community of on-farm results is that in most cases, it is not replicated or randomized in block design format, and therefore authenticity has been questioned within the research community. It is not to say that large scale plot research can not be done, however on-farm research is conducted by farmers, whose livelihood depends on getting their crop seeded, sprayed, and harvested by the quickest means possible. A properly replicated and randomized trial will take at least four times as long to seed, spray, and harvest, and NARF's best cooperators can not afford that time. Replication of the same treatment by more producers will assist in this, but this can only occur as precision farming equipment becomes available to more people.

Some of the results obtained from 1998 to 2001 show clear and substantial differences in yield, while other results raise further questions. Much of the fungicide application work shows substantial yield improvements on most years, but this of course is weather related. As determined through yield mapping, nitrogen rate has a direct effect on grain yield, which is expected. However, VRN and the basis lines for recommendation for the variability have proven to be the biggest challenge. Results of foliar application of micronutrients have been inconclusive, and demands further study.

Yield and field variability

There can be considerable yield variability on a quarter of land in consistently flat soils south of Nipawin. It only increases on rolling land, or on soils with variable texture. These variations affect grain yield, and can be visualized with a yield map. The intent of the project is to determine how to reduce the variability, which will remain a challenge on the most difficult soils.

Imagery

As discussed in Appendix A (AFIF Project # 19980166), satellite imagery is not generally acceptable as a layer of information to predict fertility demand in crop. There are too many external factors that influence the image, and therefore no further effort will be spent on satellite imagery.

Data collection and storage

Another important feature of the yield mapping equipment is that there is a permanent record of yield for the field in a given year. If calibrated properly, this record shows yield and moisture content of the crop, on a load basis and total field basis, and can be

referred to easily. Producers who use this equipment are much more likely to be able to produce for Identity Preserved (IP) markets, which is a trend of the future.

d. Further Development and Recommendations

Canola disease modeling
As indicated in Appendix D, in association with the Saskatchewan Canola Development Commission, there will be another year of testing the equipment. Hopefully there will be better canola growing conditions in 2002 than in 2001, so that we can evaluate the predictability of the weather stations, as well as the efficacy of the fungicides.

VRN technology
As indicated above, Dennis M^{c}Intosh and Cory Willness will continue to work on AFIF Project #19980166. The results of the project will no doubt raise further questions, but NARF should have a better understanding of its potentials, limitations, and the most relevant information required to develop such recommendations. Another question that demands further study is the value of soil testing results. Variability has and will always occur in the field, but variability within the sample, and between soil testing labs has been noted.

Further recommendations
An obvious recommendation to all producers who have experience with field mapping, and the equipment available, is to continue to challenge and test any new agricultural crop input that comes to the market.

e. Outputs and Measures

Agronomist's input
The project was very successful in terms of evaluating the technology available to farmers to conduct on-farm research, with yield maps generated from yield monitors and DGPS equipment available. The results of some of the trials were significant, and some of those producers have changed their farming practices on the basis of those results.

A measure of success of the project is how many other producers outside of the project's directors adopted the technology as an important cropping and management tool. This is where the project may be considered unsuccessful. This could be due to a couple of reasons. The directors of NARF have been and always will be "innovators" or "early adapters", and will be the first to consider new technology available. Many producers, particularly older ones, are intimidated by computers and their implications, and would prefer to sit back and watch what could be done, rather than do this themselves. Also, many of the later adapters are more likely to feel the financial realities of western Canadian grain production, and could not consider the capital cost of purchasing the equipment, at least with in their older farm machinery. The other reason is poor information dissemination. NARF staff could have done a better job in public promotion of the project in 2000 and 2001.

Directors' input

The most effective comment heard from producers who use precision field mapping techniques is that it quantifies results. You can visualize the effect of your crop input management decisions by evaluating differences, or lack of difference, on the yield maps. Producers can then quickly determine whether that management decision was economical, and will serve as a basis for following management decisions. Comments from producers using this technology within the project and outside are listed below:

i) Effect of variety on canola, wheat, peas, differences noted on at least four farms, much easier determination than with weigh wagons
ii) Copper application on deficient soils increased yield of CPS wheat 10 bu/ac
iii) Another producer proved the opposite for copper application on wheat. Negligible yield improvements led this producer to cease application of copper, even though soils tests indicated that levels were potentially limiting.
iv) Poor wild oat control with herbicide reduced wheat yield 10 bu/ac
v) Foliar fungicides (Tilt) on wheat and barley improved yields and kernel plumpness dramatically some years (in excess of 20 %), but not economical other years. One producer noted that in 2000, Tilt improved his gross income on his wheat by at least $70,000.
vi) Other fungicides proved uneconomical when application was recommended
vii) Over-spraying portions of fields with heavier wild oat populations proved economical, increasing yields 10 %
viii) Effect of non-target herbicide residues in sprayer tank on grain yield were quantified
ix) Effect of nitrogen and phosphorous soil inoculants on pulse crop yields
x) Consider using field mapping technology to question land assessment values and municipality mill rates

Personnel

1998 Glenda Leach, 50 %, hired June 24
1999 Glenda Leach, 100 %
2000 Glenda Leach, 100 %; summer student 50 %
2001 Glenda Leach, 100 % until November; Nancy Evenson, hired on contract
2002 Gord Pearse, hired on contract

Equipment

Equipment purchased from NARF's retained earnings are listed below:

Field Scouting equipment (Palm computer & backpack)
2 Weather stations
Computer

It should not be understated that the largest and most important equipment purchase for the project has been the in-kind contribution of the producers. There was more than

$100,000 worth of field monitors and equipment purchased by producers, many of who give up significant time in their busiest season to learn how to the equipment works.

Project Photos

There was no digital camera available specifically for this project, so attached is examples of field maps. Many pictures were taken of the variety evaluations and fall seeded canola. See Appendix E.

Innovation Fund Acknowledgement; Public Papers

Field Days and Grower Meetings
From 1998 to 2001, NARF has been seen as a major research association and cooperator with the Melfort Research Station. In every summer tour conducted at Melfort, AFIF was noted as a major sponsor of research in the northeast. In March 1999, a grower meeting with a precision farming theme was held in Tisdale. There was an additional summer tour organized by Glenda, to show all those interested in the activities of NARF.

Newsletters, Publications, and Other Communication
The NARF brochure was updated in 1998, stating the association with AFIF. A bulletin board was prepared for the 1999 Melfort field day. The NARF newsletter reached 6000 rural post boxes in northeast Saskatchewan, and was released twice a year until spring 2000. The most active and interested producers have also taken courses in satellite imagery and the operation of some of the field scouting equipment and computer mapping programs.

Displays and Signs
An AFIF sign on highway #6 greets visitors to the Melfort Research Station. It is situated in likely the most prominent place on the station grounds, and clearly designates AFIF as major sponsors of the site.

Expense Statement

Please see the attached expense statement for 2001/2002 fiscal year ending March 31, 2002.

NARF would like to thank the support of AFIF over the four years, in funding this very important project. Staff agronomists would also like to thank the producers and directors for their dedication to on-farm research with precision farming, notably Vince Walker, *Lorne Christopherson*, *Cory Willness*, *Dennis McIntosh*, Terry Gates, Al Moskal, Brent Serviss, Ed and Marguerite Beauchesne, Keith Head, Tom Boyle, Adrian Johnston, and Roy Button.

Appendix A

AFIF Progress Report #3
for Project #19980166 entitled
"Precision Farming –
Northeast Agriculture Research Foundation"
January 29, 2002

Summary

NARF is making significant headway into developing recommendations for soil sampling systems and soil test procedures that could provide meaningful data for the development of prescriptions for variable rate nitrogen (VRN) applications.

Topographic based soil sampling is emerging as the most cost-effective and reliable approach. Nitrate nitrogen based soil test recommendations appear to be of little value in developing VRN prescriptions. Conversely, tests that measure potentially mineralizable nitrogen have been identified as a major necessity for the site specific application of nitrogen.

Excellent work has evolved with the farm cooperator Dennis McIntosh and current on-farm research now evaluates VRN applications, zero nitrogen and constant rate nitrogen test strips, accurate yield mapping, and detailed data reduction and analysis in SSToolbox to complement the detailed soil sampling work.

Background and Objectives

The objective of this project was to investigate four soil sampling strategies to determine which method provided the best fertility recommendations that could then be used to develop prescriptions for VRN fertilization. Three years of sampling have been completed, other than the grid sampling which will be completed prior to seeding in 2002. Sampling systems tested to date include: topographic sampling, grid sampling, benchmark sampling, and sampling "zones" that were developed using Cargill's management zone procedure. Final results are not available but topographic sampling seems to be providing the best level of data required for evaluation at a relatively manageable cost.

Three different methods of developing management zones and applying variable rate nitrogen fertilizer by prescription have been tested. The initial tests included Cargill's and the University of Saskatchewan's method of using panchromatic aerial photography and developing management zones from greyscale analysis. In 2000 and 2001, the SOTP (Seat of the Pants) method developed by Dennis McIntosh has been used extensively to apply VRN applications. The continued cooperation of Dennis through

variable rate applications, check strips, yield mapping, and SSToolbox evaluation is effectively enhancing the soil testing data being collected at the three field sites in the study.

Project Activities and Results

In 2001, revisions were made to the original protocols to address the following two issues.

The first issue was that two of the three original sites were providing soil sampling data collection but the evaluation was of limited value because no VRN applications or check strips were being performed with those cooperators. All project work was moved to the Dennis McIntosh farm because Dennis was an experienced geo-processor writing prescriptions, applying VRN applications, leaving zero nitrogen and constant rate check strips, accurately yield mapping the test sites, and analyzing the bulk of the data being collected. We will continue to focus our resources for this project with this cooperator because he is doing an outstanding job and this work will provide the best data set for the project.

The second issue was that two years of sampling using the standard soil nitrate test and recommendation system as the data layer to base a nitrogen prescription on was not working reliably. Regardless of the sampling system used, preliminary data analysis indicates that the mineralizable nitrogen released to the crop from soil organic matter is vastly underestimated by the standard nitrate soil testing recommendations. For this reason, the CMMAS test offered by Norwest Labs was included in the 96 topographic locations sampled in 2001. *It measures "potentially mineralizable nitrogen" and this* provides an estimate of the nitrogen supplying power of the soil. Data was just received in January and has not yet been analyzed but the results look promising. Grid sampling will also include this analysis and it will be completed prior to seeding the 2002 crop and again in the fall to fulfill our project requirements.

Indications for Further Development

The CMMAS test offered by Norwest only provides an estimate of mineralizable nitrogen and hence it is really only an "index" of available nutrients. For various reasons, there is currently no recommendation system for the application of nitrogen fertilizers that goes along with the data. If this test, and potentially one or two others, proves to be a reliable indicator of the soils ability to mineralize nitrogen then further development would be required to develop a recommendation system for the test.

If the nitrate test proves useless in VRN prescription writing then a high level of extension would be required to inform farmers in the black and grey soil zones of Saskatchewan of the findings.

Satellite imagery analysis was previously suggested as an alternative soil sampling system but consultation with experts from Alberta Agriculture, the University of Saskatchewan, and the University of Guelph all recommended that we avoid allocating time and resources to that method.

Extension, Innovation Fund Acknowledgement

AFIF acknowledgement was made at the AAFC Melfort Research Farm field day and AFIF is on the NARF sponsorship sign on highway #6 across from the Melfort Research Farm. The NARF membership meets regularly and discusses ongoing project developments. NARF is supporting the continuance of the project to its completion and acknowledges the contributions from AFIF regularly to its members. NARF is not planning on releasing the findings until the project is completed in February of 2003.

Personnel

Glenda Leach is no longer on staff with NARF and the NARF board appointed Cory Willness to perform the technical work on project until suitable staff arrangements are made. Cory did the geo-referenced soil sampling and is writing the interim report. Cory is performing these duties for $750.00. Dennis McIntosh is the farm cooperator for the project and his contributions are in-kind.

Data

Soil test data that has been analyzed and recorded is attached in Appendix A. 2001 data has not been analyzed and is still being put into an acceptable format. All data will be presented in the final report.

Expense Statement

Expenses that were incurred in the past 12 months to perform this project are attached in Appendix B.

Written by Cory Willness
January 29, 2002

Appendix B

Final Report

On-Farm Assessment of Dry Bean Production in NE Saskatchewan
April 1999 – March 2001
Project # AGR9905

Submitted to:
Saskatchewan Pulse Crop Development Board

Submitted by:
Northeast Agriculture Research Foundation
Gord Pearse, P. Ag., Agronomist

I. Executive Summary

The objective of the trial was to determine the potential of dry bean production in northeastern Saskatchewan. This is a non-traditional region for dry bean production, but it is also referred to as Saskatchewan's "sure crop" region for cereals and oilseeds.

By most accounts, the project was a disappointment for NARF and its producer cooperators. In every plot, and with any agricultural crop, the largest constraint in optimizing yield and quality, and thereby net income, is the weather. Frost in the spring may have hurt many seedlings, while frost in the fall affected the seed quality. Early and mid-June frosts are unfortunately not uncommon in northeastern Saskatchewan. Most cereal and oilseed crops and field peas can recover from the damage, while dry beans can not tolerate or recover from sub zero temperatures. Although most sites received near normal summer precipitation, much of it came in thunderstorms, leading to waterlogged soils, excessive weed development, and disease pressure. It is likely that most disease issues can be overcome by evaluating production practices in central Manitoba, and by careful field selection.

The other major constraint that became apparent is the handling of the seed, to reduce seed damage at seeding and harvest. Many of the weed issues that developed over the growing season was at least partially due to the poor germination and seed damage that occurred at seeding, or handling of the seed prior to that. These constraints can be overcome with machinery investment, but the other issues would have to be dealt with first before most producers would take that next step in capital investment.

II. Objective

Dry beans are not currently grown in northeastern Saskatchewan, while field peas are grown on a very large scale, with several processing and marketing firms throughout Saskatchewan. Given the long-term prices and yield potentials of dry beans in our climate, net returns for the producer could exceed that of field pea production. Key producers in northeastern Saskatchewan were to manage a small acreage of dry beans, under similar management as field peas (ie. solid seeding), other Saskatchewan producers could learn from their experiences, negative or positive.

III. Project Design

1999

The goal was to have four producers sow approximately 10 acres each of CDC Camino pinto beans, and another four producers sow approximately 10 acres each of CDC Expresso black beans. These eight fields were to be distributed on different soil types and regions within the northeast. However, at time of seeding, only CDC Expresso was available, and was seeded on ten fields.

The research agronomist attended dry bean production courses to offer any assistance to the producers regarding seeding, harvesting, and general management. The producers then applied that information to their current expertise pulse crop production and to their day-to-day operation and machinery.

2000

Only five producers seeded CDC Camino pinto beans in 2000 under this project. Most producers who grew the beans in 1999 did not wish to try another plot, due to the extra time and effort, and also lost income.

IV. Data Collection

Data collected includes the following:

- seeding date, method and conditions
- weed control
- date of first flower
- swathing date
- grain yield and grade
- rainfall, occurrence of frost
- crop rotation
- fertility
- plant density
- harvest date
- seed size
- other significant events

Hans Van Burck, a seed producer near Star City, has grown the same varieties as those within the project, and he offered to share his experience with dry bean production in 1999, 2000, and 2001.

1999

Producers seeded all plots at 75 lbs/ac, although actual pure living seed was less than that due to seed damage. On a field-by-field case, this is the data collected:

Producer: T. Gates, Nipawin
Seeding: May 24, into mellow soil, average moisture conditions. Direct seeded in wheat stubble with paired-row shank type drill (5 and 10 inch spacing), 1.5 to 2 inches deep, and double to triple harrowed after seeding, not rolled.
Crop rotation: 1998 CPS wheat 1997 canola
1996 HRS wheat 1995 field pea
Fertility: inoculated with Nitragin granular, 5 lbs/ac; anhydrous ammonia - 45lbs/ac, no other fertilizer applied
Pre-seed pesticides: Glyfos 0.8 L/ac
Post-seed pesticides: Fusion – full rate
Odyssey – 15 g/ac (3/4 full rate) - herbicides ineffective against Canada thistle, lambs quarters and second flush wild oats
Plant density: 9.0 plants/ sq meter
First flower date: approximately July 15
Harvest date: Straight cut Oct 11
Total moisture: 9.7 inches
Yield and grade: estimated 1000 lbs/ac, #1 grade

Producer: V. Walker, Brooksby
Seeding: May 27, good moisture conditions, 2 inched deep, and rolled after crop had sprouted
Crop rotation: 1998 canola
Fertility: no fertilizer applied
Pre-seed pesticides: Roundup 0.5L/ac
Post-seed pesticides: Basagran 1 L/ac (full)
Select 0.15L/ac (full)
Plant density: 8.0 plants/ sq meter
First flower date: n/a
Harvest date: Oct 12, swathed Sept 20
Total moisture: 10.85 inches
Yield and grade: 570 lbs/ac net, #2 grade

- Vince felt that he damaged the seedlings by rolling after sprouting, and would roll beans only if there was a risk of rocks and if done the same day.

Producer: S&T Farms, Brooksby
Seeding: June 1, direct seeded following heavy harrow; average moisture conditions. 1 – 1.5 inches deep, rolled
Crop rotation: 1998 canola 1997 wheat
Fertility: inoculated with peat and corn syrup as sticker; anhydrous at 50 lbs/ac with seed; 11-51-0 at 40 lbs/ac product, with seed
Pre-seed pesticides: Gramoxone PDQ (to control RR canola)
Post-seed pesticides: Odyssey 17 g/ac
Plant density: 5.8 plants / sq meter
First flower date: n/a
Harvest date: Oct 14, swathed Sept 25
Total moisture: 10.5 inches

Yield and grade: estimated 450 lbs/ac, #2 grade

- Many seedlings emerged without cotyledons, indicating seed damage at seeding or rolling. These plants never produced leaves or flowers, which led to poor competition with the weeds.

Producer: W. Leach, Star City
Seeding: May 29, into moist conditions; seeded into preworked stubble at 2 inches deep, sown with airseeder with cultivator shanks, and rolled with pea roller June 2
Crop rotation: 1998 barley 1997 CPS wheat
1996 canola 1995 barley
Fertility: inoculated with peat; anhydrous ammonia – 80 lbs/ac fall 1998, at seed applied blend approximately 20 lbs/ac P and S
Pre-seed pesticides: none
Post-seed pesticides: Odyssey – 17 g/ac, but second flush too competitive by mid-Aug.
Plant density: 6.6 plants / sq meter
First flower date: approximately August 1
Harvest date: Straight cut Oct 11, tough
Total moisture: 9.2 inches
Frost: June 26, and Sept 14
Yield and grade: field was worked down, due to excessive weed pressure

Producer: A. Evans, Birch Hills
Seeding: June 1, into moist conditions; seeded into preworked stubble at 2 inches deep, sown with conventional airseeder with splitter boot on 12 spacing, and harrow packed after seeding
Crop rotation: 1998 HRS wheat 1997 canola
1996 barley 1995 peas
Fertility: inoculated with peat; soaked seed, anhydrous ammonia at 55 lbs N/ac applied May 28; seed placed 12-51-0 at 40 lbs product/ac
Pre-seed pesticides: Roundup 0.75 L/ac
Post-seed pesticides: Odyssey 15 g/ac (some foliar damage)
Select 0.15 L/ac
Plant density: n/a
First flower date: n/a
Harvest date: October 5, swathed ahead of combine
Total moisture: n/a, adequate moisture all year
Frost: Aug 26
Yield and grade: 40 lbs / ac, no edible grade primarily due to frost damage

Producer: G. Mayerle, Tisdale
Seeding: June 5, into moist conditions; seeded into preworked summerfallow at 2 inches deep, sown with press drill, 6 inch spacing
Crop rotation: 1998 summerfallow 1997 wheat
1996 oats 1995 peas
Fertility: inoculated with peat and water; seed applied 12-51-0 at 65 lbs product/acre

Pre-seed pesticides: none
Post-seed pesticides: Select 0.08 L/ac
Basagran 1 L/ac
Plant density: 18.5 plants/sq meter
First flower date: July 11
Harvest date: Oct 23
Total moisture: 9.5 inches
Frost: n/a
Yield and grade: 240 lbs/ac net

- hail at 1st trifoliate stage, plants unable to recover.

Producer: Meskanaw Marketing Club, Meskanaw
Seeding: June 4, into moist conditions; seeded into standing stubble at 2 inches deep, sown with air seeder, seed not soaked, 8 inch spacing, packed, not rolled
Crop rotation: 1998 wheat 1997 peas
Fertility: inoculated with peat and water; seed applied 12-51-0 at 40 lbs product/acre
Pre-seed pesticides: none
Post-seed pesticides: Odyssey 17 g/ac
Plant density: 3.9 plants / sq meter
First flower date: July 11
Harvest date: Oct 23
Total moisture: n/a, but more than adequate
Yield and grade: approx 450 lbs/ac, no grade due to excess other crop (wheat)

Producer: B. Serviss, Kinistino
Seeding: June 4, into moist conditions; seeded into standing stubble at 1.5 inches deep, sown with air seeder, 9.8 inch spacing, rolled immediately after
Crop rotation: 1998 barley 1997 canola
1996 barley 1995 peas
Fertility: inoculated with peat and water; no other fertilizer applied
Pre-seed pesticides: none
Post-seed pesticides: Odyssey 17 g/ac
Plant density: n/a, but less than 5.0 plants / sq meter
First flower date: n/a
Harvest date: Oct 23
Total moisture: 13.9 inches
Yield and grade: 130 lbs/ac, #2 grade

- This region had significant rainfall in 1999, and the bean suffered in waterlogged soils and did not fare well against weeds and diseases in this very thin stand.

Producer: E. Gerwing, Lake Lenore
Seeding: May 29, into moist conditions; seeded into preworked stubble at 2 inches deep, sown with air seeder, 8 inch spacing, rolled after
Crop rotation: 1998 wheat 1997 barley
1996 canola 1995 wheat

Fertility: inoculated with peat and water, seed soaked; broadcast 34-0-0 prior 160 lbs product/acre, 16-20-0 (24) seed applied at 40 lbs product/acre
Pre-seed pesticides: none
Post-seed pesticides: Poast 40 acre rate
Basagran 0.5 L/ac twice, unable to control pigweed and wild buckwheat
Plant density: 13 plants/sq meter on average, but variable
First flower date: July 18
Harvest date: approx Oct 18, swathed approx Oct 1
Total moisture: 9.55 inches
Yield and grade: 740 lbs/ac net

- Eric felt that the seed was much too fragile for his equipment, and sowed many splits and damaged seed, with poor emergence. Remaining plants were too thin and unable to compete with weeds effectively.

Producer: Gary Meier, Ridgedale
Seeding: June 1, into moist conditions; direct seeded with air seeder at 1 inch deep, rolled after
Crop rotation: 1998 wheat 1997 canola
1996 wheat 1995 n/a
Fertility: inoculated with granular, seed soaked
Pre-seed pesticides: Roundup and Pursuit tank mix
Post-seed pesticides: Select 0.15 L/ac
Basagran 1 L/ac
Plant density: 5.6 plants/sq meter
First flower date: estimated July 30
Harvest date: Oct 15, swathed approx Sept 30
Total moisture: est 9.0 inches
Yield and grade: approximately 450 lbs/ac net, #2 grade

- Gary seeded this plot twice, as the first time he did not soak the seed, and it was almost entirely broken and split.

2000

There was not enough seed for another eight plots of CDC Camino pinto beans, plus not enough interest in plot production within the grower base. It should be noted that the spring of 2000 was cooler than average, which is not ideal for bean seedling development. There was also a frost in July in some locations in northeastern Saskatchewan. This would have impacted the dry beans significantly.

Producer: V. Walker, Brooksby
Seeding: May 23, into average moisture conditions; heavy harrowed and seeded into heavy wheat stubble with air seeder at 1 inch deep, rolled after
Crop rotation: 1998 wheat 1997 canola
Fertility: inoculated
Pre-seed pesticides: Roundup 0.5 L/ac

- Sprayed out in July

- Germination was by far the best where the trash was completely removed from the soil. Plants that emerged through the wheat stubble were noticeably weaker and later in development, and showed signs of foliar disease.

Producer: A. Evans, Birch Hills
Seeding: May 29, into average moisture conditions; seeded into preworked stubble at 2 inches deep, sown with conventional airseeder with splitter boot on 12 spacing, and harrow packed after seeding
Crop rotation: 1998 barley 1997 canola
1996 flax 1995 n/a
Fertility: inoculated with peat; soaked seed; anhydrous ammonia at 35 lbs N/ac applied May 20; seed placed 12-51-0 at 40 lbs product/ac
Pre-seed pesticides: Edge, full rate
Post-seed pesticides: none
Plant density: n/a
First flower date: n/a
Harvest date: Sept 25, swathed ahead of combine
Total moisture: n/a, but suffered some drought stress
Yield and grade: approximately 430 lbs/ac, #2 grade

Producer: G. Meier, Ridgedale
Seeding: June 1, into moist conditions; direct seeded with air seeder at 1 inch deep into heavy wheat stubble, rolled after
Crop rotation: 1998 wheat 1997 canola
1996 n/a 1995 n/a
Fertility: inoculated with granular, seed soaked
Pre-seed pesticides: Roundup and Pursuit tank mix
- sprayed out in July, as emergence was poorer than in 1999

Producer: P. Mansiere, Kinistino
Seeding: May 25, into average moisture conditions; direct seeded with air seeder at 1 inch deep into wheat stubble, rolled after
Crop rotation: 1998 wheat 1997 canola
1996 n/a 1995 n/a
Fertility: inoculated with peat, seed treated with Apron and Thiram, not soaked
Plant density: n/a, but estimated 8 plants/sq meter
Pre-seed pesticides: Roundup at 0.5 L/ac
Frost: early July, sprayed out mid July due to frost damage
- The frost did not affect the quality of his cereals, peas, or oilseeds, but destroyed the beans.

Producer: E. Gerwing, Lake Lenore
- seeded May 20 with air seeder, and had poorer emergence than the previous year, so the plot was worked down in June, before any herbicides were applied.

Other information

Producer: Hans Van Burck, Star City

- seeded 20 acres of CDC Expresso in 1999 and 2000, and and 40 acres CDC Camino in 2001, and will seed CDC Pintium in 2002.
- soaked seed within tote bag prior to seeding, peat inoculant
- weed control was Select and Basagran, will consider Treflan or Edge fall before seeding
- swathed stand, with 2-3 % loss
- 1999 yield and quality – approx 600 lbs/ac, #2 black
- 2000 yield and quality – approx 600 lbs/ac, #2 black
- 2001 yield and quality – 800 lbs/ac, #1 pinto (<2 % pink), marketed in Manitoba
- significant damage with conventional combine (1999), much less damage with rotary in 2000 and 2001

V. Harvest

1999

Some producers had a more difficult time with harvest than others. Even though CDC Expresso grows taller than most bean varieties, and moisture was not limiting in any of the plots, there was some loss at swathing with conventional equipment. Splitting the seed was an issue for some, as the seed was quite dry. This may be due to waiting for the wild buckwheat and other weeds to dry down enough to harvest without combine damage. Dockages ranged from 22 to 35 %, due to weed seeds and damaged, frozen, and small seed. Compared to other pulse crops, this is very high and unacceptable. Harvesting the seed tough and subsequent aeration was the preferred method, but on these plots, weeds were more green and tough than the beans. Actual yields were approximately half of its genetic potential for the area, which has been quoted at 1000 to 1400 lbs/ac.

It was also the last crop harvested for every producer. This was not a concern in 1999 due to an early harvest year, but it could become a major constraint in years of late and difficult harvests. With a low and often weed-filled swath, harvest would become impossible after a snowfall, or in the spring!

2000

The one producer who harvested the pinto beans had significant splitting issues, with dockage approaching 50 %, including weed seeds, broken seed, and chaff.

VI. Marketing

1999

The entire 1999 black bean production was blended together and marketed into Manitoba through Walker Seeds, as a #2 Canada grade. Black bean prices can fluctuate dramatically, and in this crop year, selling a #2 product was very difficult, with a substantial price reduction. Only one producer managed to produce a quality that the market would freely accept (#1), and his quality would command another $0.03/lb

premium. Price to the grower for the #2 production was $0.15/lb, which given the yields and production difficulties, is an unacceptable return.

2000

No pinto bean crop was marketed in 2000, but was graded #2 Canada on a sample estimate.

VII. Conclusions and Industry Implications

Seeding and Crop Management

- It is essential to soak the seed prior to sowing. Over 60 % of the seed could be damaged before it has a chance to germinate. Damaged seed may emerge from the soil without its cotyledons, and will die shortly thereafter.
- Damage can also occur to seedlings if a land roller is used after germination. Rolling must occur immediately after seeding, but harrow packing may be acceptable in the absence of rocks.
- Weed development is a concern in solid seeded stands, even with good germination and a competitive stand. No producers were pleased with the spectrum of weeds controlled by Basagran, and Odyssey was often ineffective against some problematic weeds and second flushes, and caused damage to the plants in a few cases. Fall or spring application of a trifluralin or ethafluralin product will also help, but post seeding herbicide application will be required.
- Dry beans are not well suited for reduced tillage or direct seeding operations, as development was noticeably slower and weaker in heavy residue situations. This is likely due to cooler soil temperatures, but perhaps also soil borne diseases. Perhaps seed with a damaged coat are particularly sensitive to these conditions. These plots were the last crop seeded by the cooperators, which should mean warmest soil conditions. By contrast, field peas are well suited to cool soil conditions, and are often the first crop sown in the spring.
- Many of the rotational benefits that other pulse crops grown in Saskatchewan have do not apply to dry beans. They are more expensive to fertilize, and there is less residual soil nitrogen from fixation. They do not compete with weeds as well, and they do not produce enough fodder for a livestock feed option. The benefits of field peas in rotation in northeastern Saskatchewan are well documented and understood.
- Dry beans have no ability to recover from hail damage, and would be expensive to insure.
- Conventional rotor combines cause much more damage to the seed at harvest than rotary combines, especially if the seed moisture is dry (15 %) or less. Any seed producer should consider a rotary combine, as they could pass problems on to commercial growers with seed coat damage.
- Dry beans will be the last crop seeded in the spring, and the last crop harvested in the fall. In 1999, the significant spring frosts were avoided, but seed quality was affected by fall frosts. It was anticipated that the summer frost of 2000 east of Melfort would have diminished any yield expectations.

- Field selection is more critical with dry beans than other pulses, cereals and oilseeds. Beans are prone to flood damage as well as frost, and their growth habit will cause harvest difficulty in rolling terrain and rocky or stony soils. Field peas are difficult enough on these soils, and dry beans would be impossible.

Markets and Industry Development

- Given current growing conditions, varieties available, value of other cropping options, and typical farm machinery, dry bean production will remain an uncertain and high risk crop for producers in northeastern Saskatchewan. Most producers would not invest in machinery to improve seed quality under current conditions.
- In 1999 and 2000, all cooperators also had field peas in rotation. Without exception, field peas produced much better returns per acre than dry beans. However, it should be noted that this was the state of the Canadian field pea industry prior to 1985, before production issues were addressed and both public and private institutions developed adapted varieties. There is room for improvement for variety development in terms of maturity, plant height, or at least pod height, disease resistance, frost resistance, seedling vigour, and seed coat breakage.
- It was agreed that the market for dry beans is one that will often accept only the highest quality and top grades. Failure to produce to this quality will result in substantial price reductions, or worse, an unsaleable product. With frost or poor harvest conditions a constant threat for northeastern Saskatchewan producers, this becomes a risk too great.

Appendix C

Final Report – November 26, 2001

Demonstration of Fall Seeded vs. Spring Seeded Canola

Nancy Evenson
Northeast Agriculture Research Foundation

Acknowledgements

Funding was supplied by the Saskatchewan Canola Development Commission and AgriFood Innovation Fund

Thank you to farmer co-operators Terry Gates and Vince Walker

Executive Summary

The objective of the study 'Demonstration of Fall Seeded vs. Spring Seeded Canola' was to expand research on fall seeded canola performed on a small scale and evaluate the differences between fall seeded and spring seeded canola on a farm scale basis. In the growing season of 2000, an initial study was done on fall seeded canola at three sites on a farm scale basis. The following report summarizes the 2001 growing season during which this project was performed on only one site, the Northeast Agriculture Research Foundation site at Melfort. Three treatments were included in this project; fall seeded canola, early spring seeded canola and spring seeded canola

The 2001 growing season was very dry with a total of only 101.3 mm of precipitation from April 1/01 – August 31/01 representing 41% of the normal precipitation.[1] This resulted in poor soil moisture conditions and hard, lumpy soil. Therefore, seeding depths were increased to ¾ - 1 inch in all treatments to ensure moisture for the seed. The dry, lumpy soil may have also reduced soil to seed contact. The results of these dry conditions were uneven and patchy emergence in the fall seeded and early spring seeded treatments. Frost was also a factor in early season growth of the fall seeded and early spring seeded canola. On May 22, 23 and 24 the overnight lows were at or below zero degrees Celsius. Visual observations indicated a reduced number of healthy plants and those that were not severely damaged eventually recovered.

In conclusion, the 2001 growing season was dry which limited crop growth. It was also limited by early spring occurrences of frost; therefore affecting the fall seeded and early spring seeded treatments. Final yield data indicated the spring seeded canola had the highest yield at an average of 24.80 bu/ac followed by the early spring seeded canola at 19.64 bu/ac and then the fall seeded canola the lowest at 13.64 bu/ac.

Demonstration of Fall Seeded vs. Spring Seeded Canola 1999-2000

The initial year of this project was started in the fall of 1999 at three sites: Vince Walker – Brooksby, Terry Gates – Nipawin and the Northeast Agriculture Research Foundation – Melfort. Due to poor germination, the plots at Brooksby were plowed under and the study was not continued there.

Results at Nipawin indicated that the fall seeded canola had the highest yield at 32.6 bu/ac, followed by the early spring seeded canola at 31.0 bu/ac and the lowest was the spring seeded canola at 20 bu/ac. The fall seeded canola may have been higher as the co-operator reseeded some of that treatment on May 23/00.

Results at Melfort indicated that the spring seeded canola had the highest yield at 32.6 bu/ac, then the early spring seeded canola at 26.4 bu/ac and finally the lowest was the fall seeded canola at 25.9 bu/ac. This site was affected by frost on three different dates in May 2000, which affected all three treatments. After this year of study a continuance of the project was requested but reduced to only the NARF site at Melfort.

Demonstration of Fall Seeded vs. Spring Seeded Canola 2000-2001

The only site for 2000-2001 is at the NARF Research and Demo site. The project included three treatments and was replicated twice.

The three treatments were as follows:

1. Fall seeded canola
2. Early spring seeded canola
3. Spring seeded canola

General Information

The trial was direct seeded on pea stubble with a 9" Conserva-Pak drill with knife openers.

Soil tests indicated 14.24 lbs. N/ac.

Fall Seeded

Seeding Date	Nov 3/00	
Seeding Rate	6 lbs./ac	
Fertilizer	11-51-0 46-0-0	40 lbs./ac seed placed 28 lbs./ac side banded
Seeding Depth	¾-1 "	Uniform seed placement was difficult due to dry soil conditions
Germination	May 3/01	Some emergence in the seed rows

Seeding conditions were dry and some of the soil was forming large clumps.

The Conserva-Pak 9" drill resulted in greater soil to seed contact than the John Deere zero-till disc drill used in the fall of 1999.

The germination of the fall seeded canola was slow and emergence was patchy.

Early Spring Seeding

Seeding Date	May 1/01	
Seeding Rate	6 lbs./ac	
Fertilizer	11-51-0 46-0-0	40 lbs./ac seed placed 28 lbs./ac side banded
Seeding Depth	¾ - 1 "	Seeding at this depth was necessary in order to reach soil moisture (1 – 1.5"). There was approximately ¾-1" of soil packed above the seed row and the openers placed a lot of soil up onto the ridges between the rows. If a heavy rainfall were to occur, the canola may be seeded too deep.
Germination	May 8/01	Beneath the surface some of the seeds had germinated and some were sitting in dry soil. No plants had emerged above ground yet.

Regular Seeding

Delayed due to the lack of surface moisture.

Seeding Date	May 23/01	
Seeding Rate	6 lbs./ac	
Fertilizer	11-51-0 46-0-0	40 lbs./ac seed placed 28 lbs./ac side banded
Seeding Depth	1 "	
Germination	May 29/01	

General Weather

Melfort Research Station Data[1]

Month	Precipitation (mm)	Precipitation (mm) Total from April 1/01
April 2001	11.1	
May 2001	9.0	20.1
June 2001	23.4	43.5
July 2001	46.4	89.9
August 2001	11.4	101.3

Temperatures

Frost occurred in the area on May 22, 23, & 24 when the overnight low reached 0.0°C, -1.1°C and –0.2°C respectively.[1] Observations on May 23 indicated that the frost had damaged approximately 15-20% of the crop that had emerged. *This may be an underestimation of the damage because visual* observations on May 18 indicated good emergence within the seed rows and visual observations on May 23 indicated a significantly reduced number of plants.

On May 30 visual observations indicated complete emergence of the fall seeded treatments. These stands appeared thin due to damage from wind, frost and the lack of moisture. The spring seeded treatments still had plants emerging at this point. The plants that had emerged earlier and were not severely damaged by the frost eventually recovered.

Plot Plan

North

SPRING SEEDED	FALL SEEDED	EARLY SPRING SEEDED	SPRING SEEDED	EARLY SPRING SEEDED	FALL SEEDED
6	5	4	3	2	1

Harvest Information

II)	III) Seeding Date	Seed Harvest (lbs.) Strip 1	Seed Harvest (lbs.) Strip 2	Total seed for each plot (lbs.)	Area per plot (acres)	bu/acre
1	Fall	152.12	161.38	313.50	0.44	14.25
2	Early Spring	233.25	249.12	482.37	0.44	21.93
3	Spring	282.19	276.02	558.21	0.44	25.37
4	Early Spring	189.60	191.80	381.40	0.44	17.34
5	Fall	107.14	179.46	286.60	0.44	13.03
6	Spring	276.90	256.18	533.08	0.44	24.23

Yield Averages

Fall Seeded	13.64 bu/ac
Early Spring Seeded	19.64 bu/ac
Spring Seeded	24.80 bu/ac

References

1. Melfort Research Station weather data from Environment Canada.

Appendix D

2001 Report CARP SCDC 11-/00-01

Investigate Disease Modeling for Sclerotinia Stem Rot In Canola — 2001

Submitted to: Saskatchewan Canola Development Commission

Submitted by: Dennis McIntosh, NARF Director
C/O Northeast Agriculture Research Foundation

April 2, 2002

1. Objectives

1. Small Plot Trial

The replicated small plot trial was designed to evaluate the canola yield effects of 6 different fungicide treatment protocols. Contact (Ronilan) and systemic (Quadris) fungicides were applied on canola plots according to generally accepted staging criteria (20 - 30 % bloom) and according to the recommendations of the computerized disease modeling software in the Pessl field weather station.

2. On-Farm Trials

On-farm trials were set up to assess the feasibility of using the weather stations at the farm level and to determine the validity of the disease modeling software. These trials were designed to compare the results of applying fungicides according to plant staging to the results obtained when applications were made on the basis of the recommendations provided by the disease modeling system in the Pessl weather stations. 1 or 2 half-rate fungicide applications were made in the second treatment strips according to the spraying "alerts" provided by the weather stations. Trial design was complex and consequently it was difficult, given the large number and widely dispersed nature of the fields, to collect all data components from all field locations.

2. Results

1. 2001 Weather Conditions

Drought or near-drought conditions prevailed throughout the 2001 growing season. Total growing season rainfall was in the range of 2.5" to 4". Approximately 10 to 15 % of this rainfall was in the form of heavy dew. Temperature conditions were generally favorable to support the growth of sclerotia.

2. Crop Establishment

Crop emergence was variable at the driest field locations but generally adequate at the Walker and Moskal sites. Variability in plant counts was noted but did not appear to be a yield-limiting factor except at the driest sites.

3. Petal Testing & Pre-swathing disease ratings

The petal testing was performed on samples from the check area of the fields/plots. Canola plants were also examined for evidence of disease lesions prior to swathing.

	Moskal	Walker	Serviss	Leach	Hurd
Petal Test No.1, Number out of 16, July 3	7	5	4	5	4
Petal Test #2, Number out of 16, July 17	2	0	0	0	0
Pre-swathing Disease Ratings	Nil	Nil	Nil	Nil	Nil

4. Plot Results

All results are the mean of 4 replicates. No significant yield differences were found between the control and fungicide treatment plots. Please refer to *Sclerotinia Modeling Annual Report (SCDC_01B.doc) for a complete report on* the plot results.

5. On-farm Yield Results

Farm	Treatment 1 bu./acre	Check 1 bu/acre	Treatment 2 bu/acre	Check 2 bu/acre	Notes
Moskal(1)	27.5	28.0	28.2	28.1	Average 28.0
Walker(1)	33.0	32.1	34.1	34.2	Average 33.5
Hurd(2)	35.0	27.0	31.1	27.3	Weigh wagon
Leach(2)	21.3	24.2	19.8	23	Weigh wagon
Serviss(3)	N/A	N/A	N/A	N/A	Average 18.4

(1) No significant yield difference between treatments/checks

(2) Yield differences do not appear to be related to sclerotinia disease as there was no pre-harvest pathological evidence of disease lesions on canola plants

(3) No results were reported as the farm cooperator failed to collect valid yield map data

6. Seed quality

The yield results of the Hurd and Leach fields were measured with a weigh wagon. Seed samples from these fields underwent quality assessments. Fungicide treatment did not appear to affect the quality of the seed.

	Sprayed Treatment			Check		
	Bushel Wt	Thousand Kernel Wt	Grade	Thousand Kernel Wt	Bushel Wt	Grade
Hurd	668.8 gm/l (51.4 lb/bu)	3.57 gm	No. 1	3.64 gm	660.6gm/l (50.8 lb/bus)	No.1
Leach	648.0 gm/l (45.4 lb/bu)	3.04 gm	No. 1	2.84 gm	648.0 gm/l (45.4 lb/bu)	No. 1

3. Pessl weather station performance

1. Reliability

2 of the 5 Pessl weather stations used in this project had service issues that compromised the data collection. One of the units suffered from random resetting of the clock (date information) confounding interpretation of the results. A second unit experienced repeated failure of the dry cell batteries used to power the unit. These malfunctions were not resolved during 2001.

2. Data collection

It was necessary to physically visit each weather station site every few days during the disease season to download data from the stations. This is a cumbersome and costly method of obtaining the field data. A cell phone interface is apparently available for remote downloading of the station data however this increases the cost of each station by more than 50 %.

3. Disease modeling software

The disease modeling software appears to be designed as a means of inspecting the weather data and forwarding it by email to a central processing location. This design is consistent with a commercial process intended to broadly market the disease modeling results to producers.

The appropriateness of the disease model was questioned by numerous parties since the model does not use a measurement of soil moisture in its estimations. This shortcoming may partly account for the model triggering fungicide application events although there was no evidence of late-stage disease lesions on the plants and no significant yield benefit associated with these fungicide applications.

4. Methods of yield measurement

4. Plot measurements

Plot measurements are well suited to measurement of yields when there are numerous experimental treatments. A large number of experimental treatments would be costly and difficult to layout on a field scale.

5. Weigh wagon

Weigh wagon methods appear to be poorly suited for yield measurements in these disease trials unless the trials include a large number of replicate measurements. Canola yields may be highly variable across a field and a few weight measurements do not provide an adequate picture of the within-field variability. A large number of replicates (e.g. 15) and weight measurements would complicate trial design and increase the cost.

6. Surface interpolation of yield monitor data

In the field-scale trials where yield monitors were used to record yield data this data was post-processed using surface interpolation methods. Inverse distance to a power surface interpolation was applied to the raw data and the surfaces were subsequently analyzed to determine yields in the control and experimental strips in the fields.

This method of data collection and processing appears to have a number of advantages over plot or weigh wagon methods.

This method provides a clear yield snapshot of the entire field and areas of anomalous yields can be rejected in the data analysis process. With this method the individual yields in 8,000 pseudo plots per 160 acre field can readily be measured with each plot being the same size. Also, other types of experimental treatments such as fertilizer treatments can be compared on a plot by plot basis in the same field by layering the surfaces.

5. Conclusions

The data from 2001 indicate there was no economic benefit from fungicide applications intended to control sclerotinia stem rot in canola. This finding applies when fungicide applications were applied according to both plant staging methods and the recommendations from Pessl weather stations and sclerotinia disease modeling.

6. Expenses

Fungicide and fungicide application	$5,289.14
Petal test, seed quality	$250.00
Site travel	$500.00
Labour, 2 months	$6,000.00
Total (Not including matching MII of $8,000.00 for plot study)	$12,039.14

7. Personnel

Glenda Leach, the NARF manager until November 5, 2001 was responsible for data collection at the farm cooperator sites.

NARF director Dennis McIntosh collated the field-scale data, carried out the post-processing of the yield data and prepared the SCDC report.

Randy Kutcher from the AAFC Melfort Research Farm conducted the plot scale trials with funding in the amount of $8,000.00 from the MII program. NARF supplied a Pessl weather station for the plot trials.

8. Suggestions for future years

1. Methods

Continuing the plot scale study and performing fewer, but more tightly controlled field-scale studies would likely improve the quality of the findings within an acceptable budget. The costs of fungicide, fungicide application, weather stations, field setup and data collection become prohibitive within the financial scope of this project when the project includes a large number of field-scale studies.

There is a consensus that fungicides applied with ground methods not only improve the spatial accuracy of the applications but also obtain maximum effectiveness from the applications.

2. Field-scale yield measurement

The validity of the yield results of field-scale studies are enhanced by using surface interpolation techniques in combination with raw yield map data. Weigh wagon methods produce a scarce data set that may result in unreliable associations.

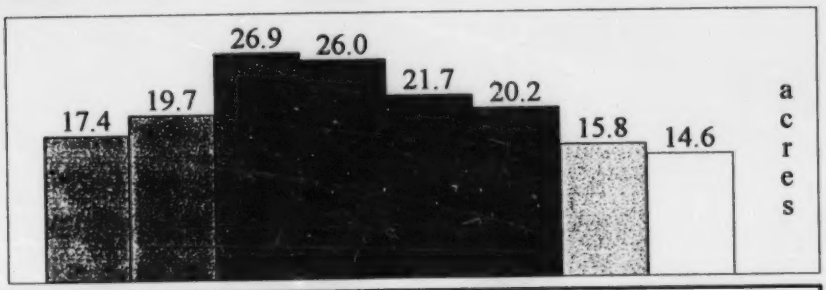
Yield Map (2001)
DON MEIER
SOUTH 26-45-17W2

Harvested Acres: 162.22
Date: 11/10/00-12/10/00
Yield: 51.84 bpa
Moisture: 14.41%
Harvest Hours: 14.88

GREENSTAR™ JDmap™ 4.0
JOHN DEERE PRECISION FARMING SYSTEMS

Wheat(Hrd Rd Spr)(Low)

65 and greater	50 - 54	35 - 39
60 - 64	45 - 49	less than 35
55 - 59	40 - 44	



Appendix E - Yield Maps

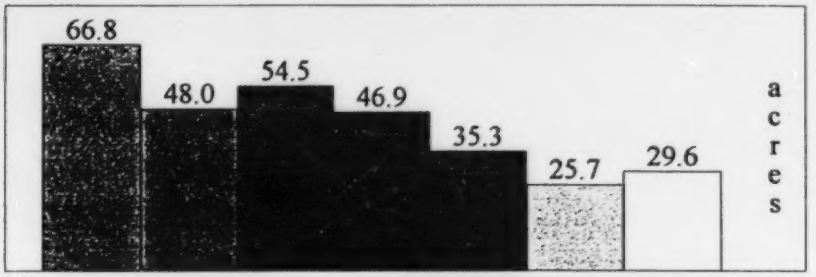
Yield Map (2001)
S 1/2 29-46-16-2
CERT AC INTREPID

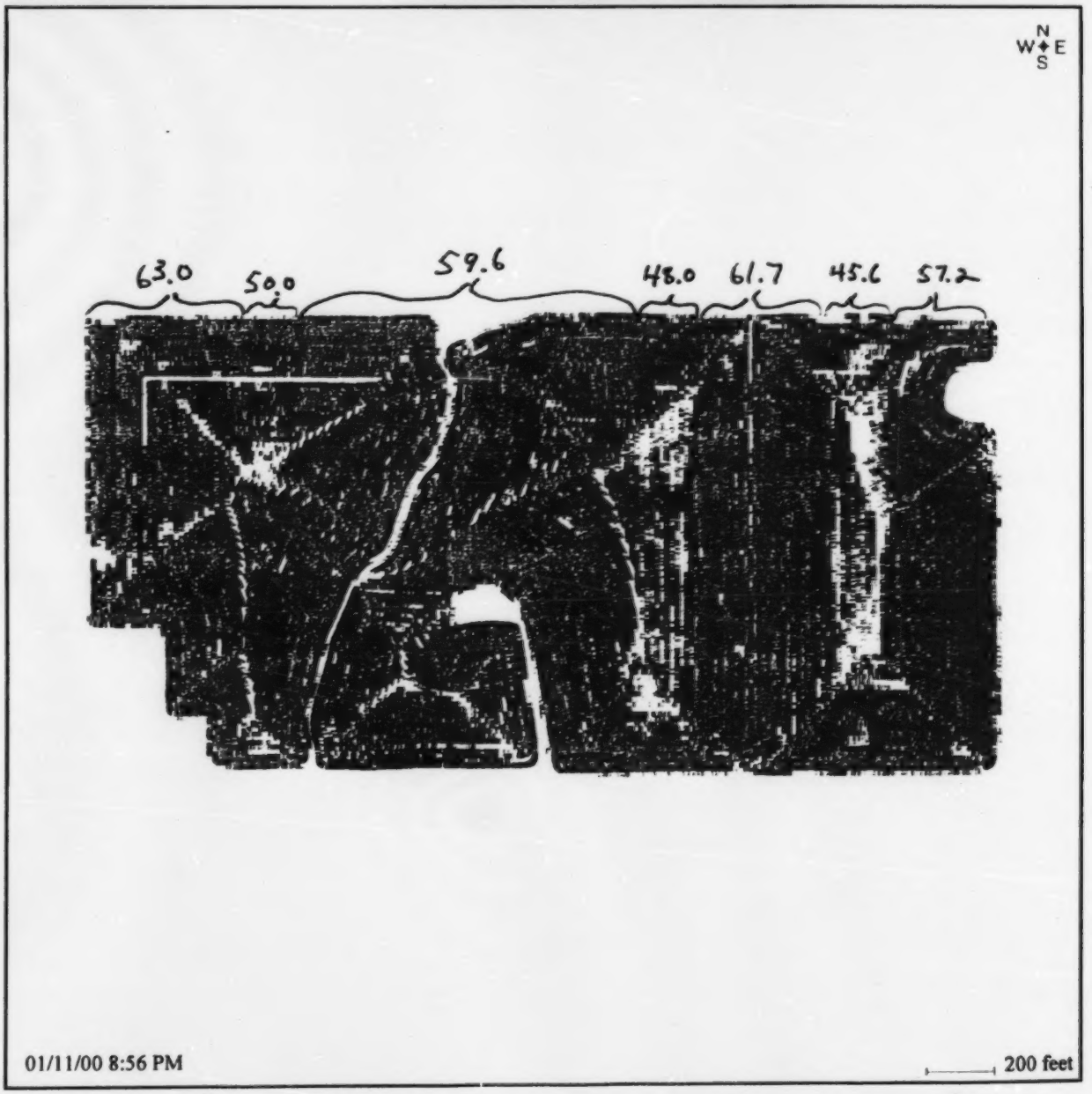
Harvested Acres: 306.89
Date: 24/10/00-26/10/00
Yield: 57.62 bpa
Moisture: 13.06%
Harvest Hours: 27.31

GREENSTAR™ JDmap™ 4.0
JOHN DEERE PRECISION FARMING SYSTEMS

Wheat(Hrd Rd Spr)(Low)

65 and greater	50 - 54	less than 40
60 - 64	45 - 49	
55 - 59	40 - 44	



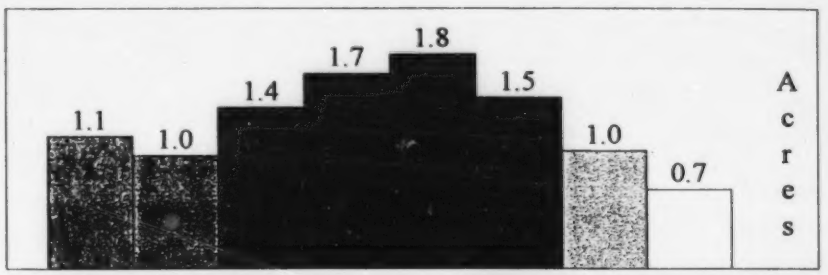


Yield Map (1999)
S1/2 06 47 16 2
CANOLA STRIP TRIALS

Harvested Acres: 10.11
Date: 28/09/99
Yield: 44.70 bpa
Moisture: 11.18 %

Canola

51 and greater	42 to 44	33 to 35
48 to 50	39 to 41	less than 33
45 to 47	36 to 38	



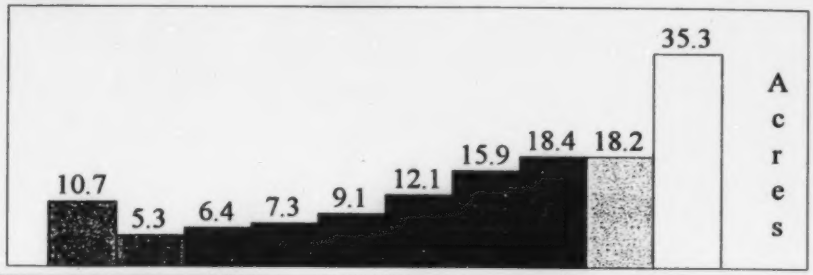
GREENSTAR
JOHN DEERE PRECISION FARMING SYSTEMS

Yield Map (1999)
SE 34 46 16 W2
REG.AC CRYSTAL-SRP W

Harvested Acres: 138.74
Dates: 23/09/99 - 24/09/99
Yield: 77.93 bpa
Moisture: 13.39 %

Wheat (Sft Rd Wtr)(Low)

105 and greater	85 to 89	65 to 69
100 to 104	80 to 84	less than 65
95 to 99	75 to 79	
90 to 94	70 to 74	



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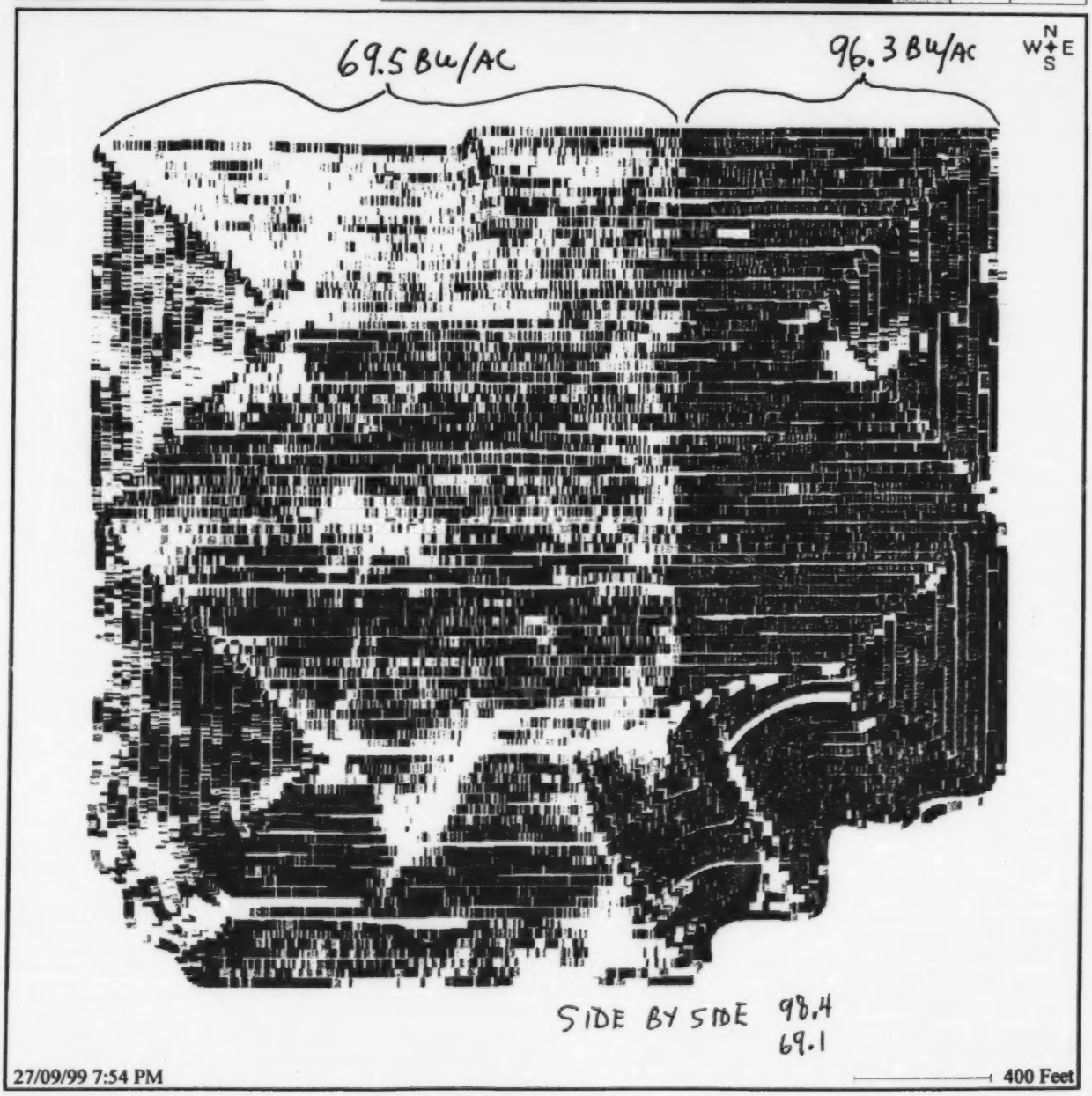

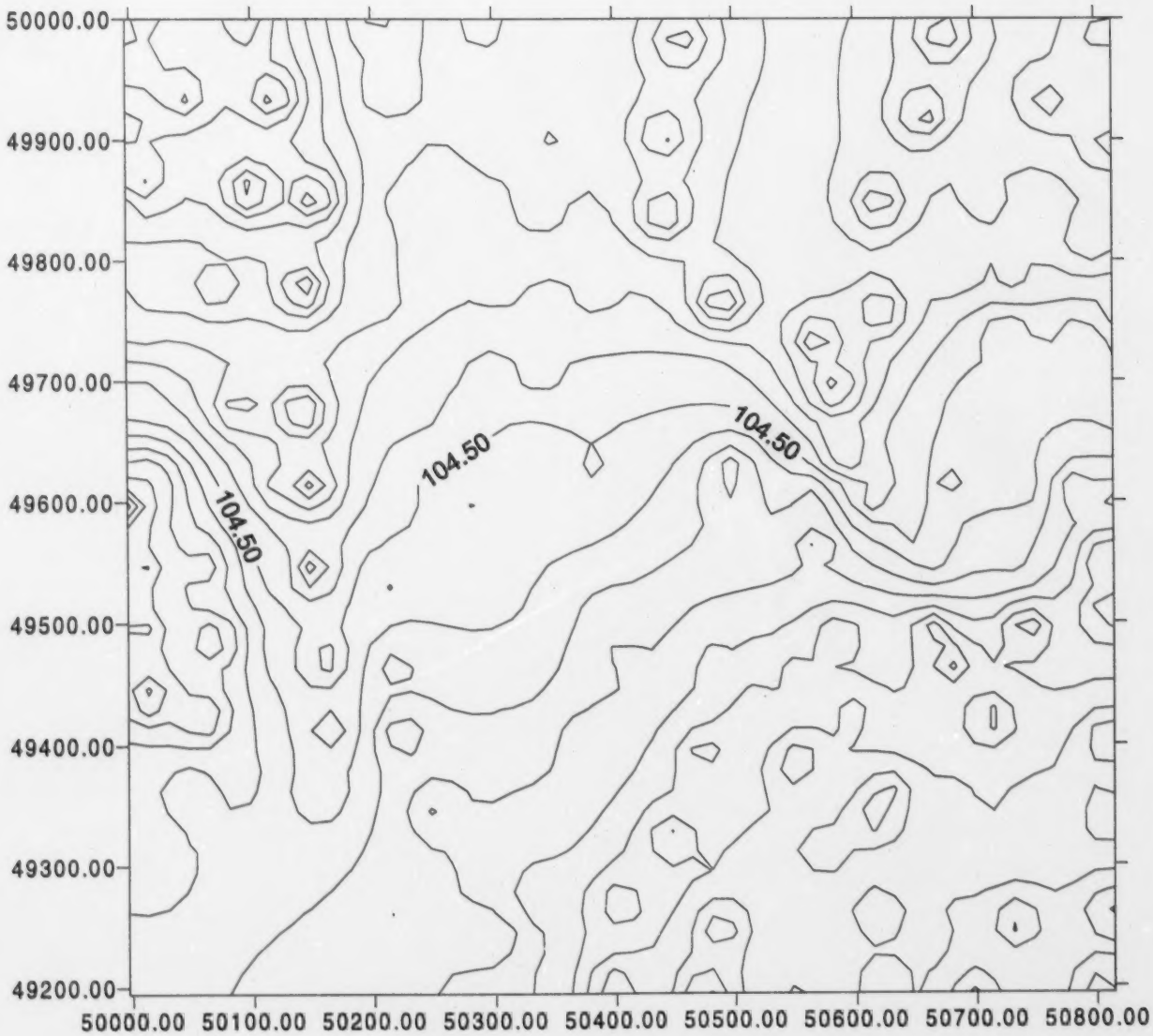
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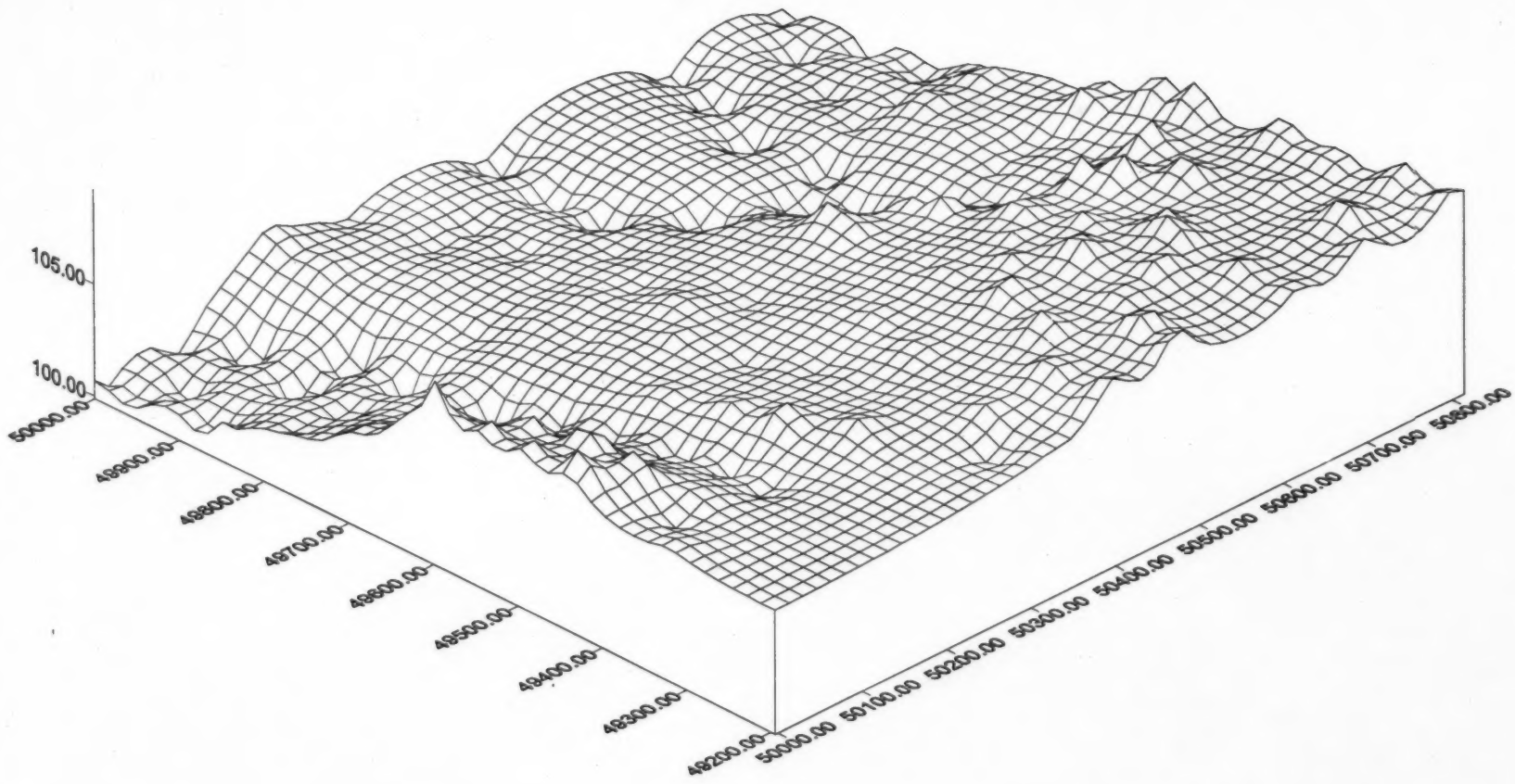
Jane Mary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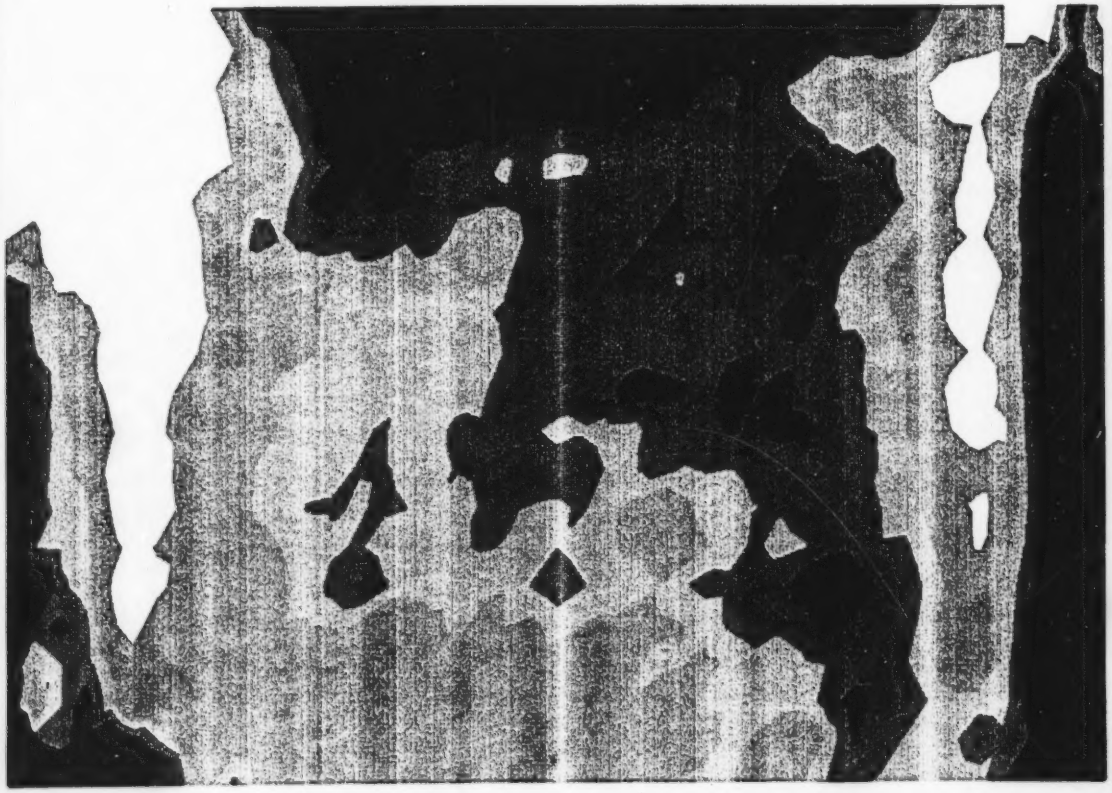
Yield, F11:NW1/4



Crop:	Wheat
Description:	Yield
Area:	8.0 ac
Avg Yield:	52.9 Bu/Ac
Avg Moisture:	14.8 %

- △ Marker Type A
- □ Marker Type B
- ○ Marker Type C
- × Marker Type D

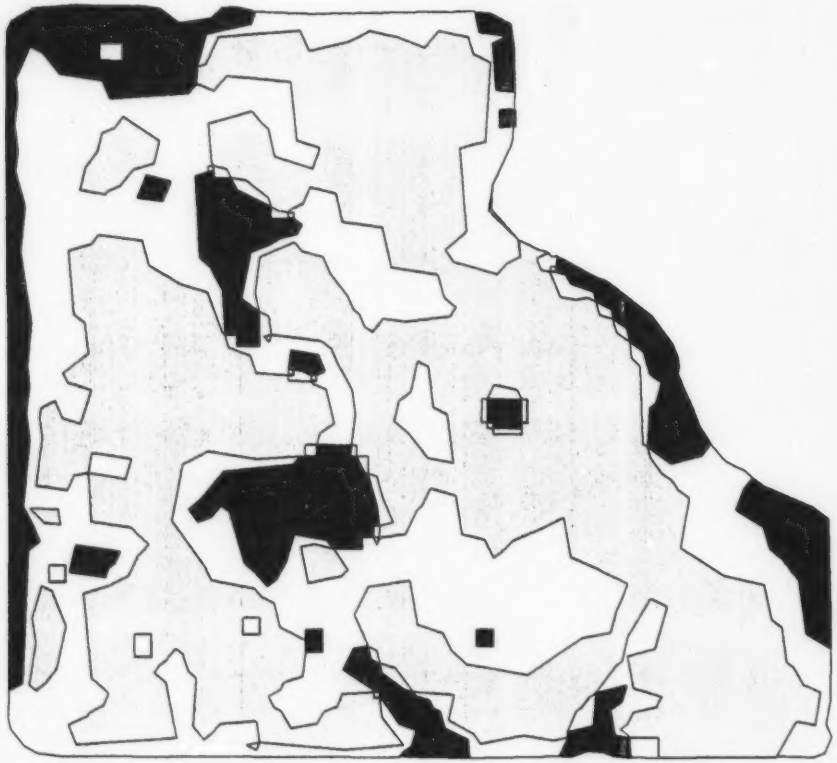
- 62.7 - 71.6 Bu/Ac
- 56.6 - 62.7 Bu/Ac
- 53.7 - 56.6 Bu/Ac
- 51.2 - 53.7 Bu/Ac
- 49.4 - 51.2 Bu/Ac
- 47.6 - 49.4 Bu/Ac
- 45.5 - 47.6 Bu/Ac
- 43.0 - 45.5 Bu/Ac
- 38.7 - 43.0 Bu/Ac
- 0.0 - 38.7 Bu/Ac

Printed Thursday, September 3

Ag Leader Technology

Dennis McIntosh Field; 98 (92.7 ac.)

Management Units



New N Recommendation: Mgmt_z_cls

500 0 500 Feet

Date: Jul 27, 1999
Field Name: Dennis McIntosh Field; 98
Farm Name: Dennis McIntosh Farm
Client Name: Dennis McIntosh
Total Acres: 92.7
Field Boundary Start Location:
Latitude: 52.96415491
Longitude: -104.68466095

Management Units
- Low (13.6 ac.)
- Mid (31.8 ac.)
- High (47.2 ac.)

New N Recommendation: Mgmt_z_cls
- 1
- 1 - 2
- 2 - 3